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U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere.
When written as ё in Russian, transliterate as yё or ё.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	$\sinh^{-1}$
cos	cos	ch	cosh	arc ch	$\cosh^{-1}$
tg	tan	th	tanh	arc th	$\tanh^{-1}$
ctg	cot	cth	coth	arc cth	$\coth^{-1}$
sec	sec	sch	sech	arc sch	sech^{-1}
cosec	csc	csch	csch	arc csch	csch^{-1}

Russian	English
rot	curl
lg	log

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A statistical analysis of irregular quasi-optical lines (beam guides) with the aid of computer(s)[1].

N. N. Voytovich.

FOOTNOTE [1]. Article is written based on materials of author's candidate dissertation "The simulation of irregular beam guides in the electronic computers". ENDFOOTNOTE.

Is set forth the method of the study of the irregular quasi-optical (lens or mirror) lines of electromagnetic energy with the aid of the simulation of such lines in the electronic computer; are given some results of analysis.

Introduction.

Several years ago quasi-optical lines [1-3] proposed (called sometimes beam guides) proved to be very effective means for the transmission of power in the range of millimeter and submillimeter electromagnetic waves. Such lines have acceptable transverse sizes/dimensions and possess sufficiently small radiation losses. In the simplest case the beam guide is large-period system from the optical elements/cells (lenses, mirrors), which focus wave beams. These elements/cells are called phase correctors, since in the quasi-optical approximaticn/approach essential is only their effect cn phase field distribution.

Real beam guides, as a rule, imperfect; in them are present one or the other heterogeneities, which carry the random character: an inaccuracy in production and installation/setting up of correctors, displacement and deformation of correctors in the process of operation. With the very small transverse sizes/dimensions of correctors (it is more precise, small numbers of Fresnel $c=ka^2/L$, where k - wave number in the void, a - transverse size/dimension, L - the distance between the correctors beam guide is one-mode, all waves, except one, fundamental, are propagated in it with the high attenuations. During the analysis they are irregular beam guides in this case it is considered only transformation on the heterogeneities of fundamental wave into the waves of the highest types, and inverse transformations they disregard. As a result for determining the average/mean losses in the beam guide with the random heterogeneities it suffices to determine the losses of wave on one, average/mean in the value, heterogeneity and to multiply by the total number of heterogeneities [4, 5].

Energy losses in the one-mode beam guide depend substantially on the form of phase correctors, i.e., from the law of change by the corrector of phase field distribution.

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It is possible to find such forms of the correctors (in any case, in this or another class), which will provide on the average the greatest stability of beam guide to the random heterogeneities of the specific type (for example, see [6]). However, even with the optimum forms of correctors in the sufficiently long beam guides losses are comparatively great. For example, with c=1.5π in the beam guide whose correctors are subjected to random shifts/shears on the average to 0.15 of radius, due to the selection of form it is possible to lower losses only to the level 0.5 dB to one corrector. In order to decrease the losses, it is necessary to switch over to systems with large numbers of Fresnel c. In this case the beam guide becomes substantially multimode, on each heterogeneity occurs the transformation of one its own wave into another and back, the structure of field at the output considerably becomes complicated. However, in the presence of the corresponding receiving system such beam guides it is possible to use.

In the extreme case of infinite c analysis by the irregular of beam guides it is possible to carry cut according to the laws of geometric optic/optics, interpreting beam by infinitely thin beam and studying the trajectory of this ray/beam. In the presence of random heterogeneities the ray/beam, generally speaking, will differ from the axis of beam guide. The properties of beam guide are determined by the characteristics of the random variable of this divergence. The very important from these characteristics is the probability of retaining/preserving/maintaining the ray/beam in the beam guide, i.e., probability that not on one of the correctors the amount of deflection exceeds the sizes/dimensions of aperture.

The results of geometric-optical analysis have limited application. The fact is that the beams, which are propagated in the real beam guides, have finite transverse dimensions[1] (c - it is always certain, although it can be sufficiently large).

FOOTNOTE [1]. The transverse sizes/dimensions of beam are of the order $\sqrt{2f/\kappa\sqrt{(4f/L)-1}}$, where f - focal length of correctors. ENDFOOTNOTE.

The output of geometric ray/beam beyond the limits of aperture does not completely mean that entire/all energy of beam is lost: some part of it nevertheless remains in the beam guide and in a specific manner it is propagated further. On the other hand, if ray/beam approached sufficiently close to the edge of corrector, then this means that its "facing/trimming" its its beam hit by certain its part beyond the limits of corrector. Beam shape in this case is distorted, and its further propagation no longer can be described by the trajectory of ray/beam. Thus, geometric-optical approach can be reliably applied only in the case when is negligibly small the probability of the approach of ray/beam even closely to the edge of any corrector. For this either the beam guide must be sufficient to short ones, so that ray/beam does not manage still it will approach the edge or heterogeneities are so small in the value that for entire elongation/extent of beam guide they do not take away ray/beam far from the axis. In any of these cases the width of beam must be sufficiently small in comparison with the sizes/dimensions of the apertures (c - it is sufficiently great).

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By the most acceptable method of the analysis of irregular beam guides with finite numbers of Fresnel (not so small that it would be possible to consider the beam guide one-mode) they are, apparently, the simulation of such beam guides to the computer(s), the set/dialing of the corresponding statistical material on the uniform totality of models the treatment of this material the methods of mathematical statistics. In order to construct the model of irregular beam guide, it is necessary to assign the values of heterogeneities, also, on the known field of exictation taking into account these heterogeneities to determine field at the output of the beam guide. During this simulation it is necessary to determine field in one section of the beam guide (let us say, at the input of certain corrector) on the field in other section (at the output of the preceding/previous corrector) when between these sections the heterogeneities are absent. This can be made directly by Huygens's principle - approximate solution of the equation of Maxwell. However, the straight/direct computation of appearing in this case integrals requires high computational expenditures and makes it possible to simulate only separate beam guides [7]. But the conclusion/output, made on the separate models, it is not possible to consider reliable. Is described below reception/procedure [8, 9], with the aid of which the integration is replaced by matrix transformation; this substantially decreases the space of computations and is made itself with that actually attained the simulation of large statistically uniform ensembles. Of the comparison of different models of one ensemble it is possible to determine not only middle of the characteristic of beam guide, but also the character of the distribution of its parameters around its average/mean values.

DESCRIPTION OF METHOD.

For simplification in the translation from the corrector to the corrector the field in the cross section of beam guide should be decomposed/expanded in the series/row along selected in a specific manner complete system of functions. The effectiveness of resolution and entire method to a considerable degree depends on the selection of such base line of functions. Most convenient for the multi-honey beam guides proves to be the system, selected from the following considerations. As is known [10, 11], Gaussian beam, propagating, in the irregular beam guide with infinite correctors (c=∞), is not changed its form, but only it is displaced according to the laws of geometric optic/optics. Logical to assume that with final c the beam has sufficiently simple structure, in any case until it approaches closely to the edge of corrector. This fact can be utilized, connecting specifically the center of resolution on each corrector with the position of beam on it, for example, after taking as the center of resolution the "center of gravity" of beam.

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With this approach it is not possible to utilize as the base line ones its own waves of beam guide with the limited correctors; since the center of resolution is displaced with respect to the center of corrector, the interval where these waves are determined, it does not coincide with the aperture[1].

FOOTNOTE [1]. In work [12] it is proposed as the base line ones to utilize its own waves of beam guide with the limited correctors, "cabled" to the center of corrector. A deficiency/lack in this method is the fact that the analytical expressions for their own waves are known only confocal beam guides; on the other hand, with increase of c increases a quantity of waves, which have in effect zero losses, so that with large c series/rows greatly badly/poorly converge. ENDFOOTNOTE.

More convenient are their own waves of beam guide with the infinite correctors, described by polynomials of Laguerre (for the two-dimensional case - Hermite) [13]. These waves are determined on the entire infinite plane (straight line) and satisfy the requirements of simplicity of translation from one corrector to the next - with the translation VSS the integrals are calculated in an explicit form. As a result of integration is obtained the new beginning of resolution; it is determined from the same formula that also the trajectory of geometric ray/beam, but can be artificially touched up for decreasing the quantity of the waves considered. At the same time is separated/liberated certain general/common/total for all waves phase factor, which characterizes the direction of further propagation of beam. In all these expressions to be contained the information about the heterogeneities, connected with the position of the preceding/previous corrector and a change in the direction of the axis of beam guide. The account cf the limitedness of correctors and heterogeneities of the type cf the fluctuation of the sizes/dimensions of correctors is conducted on each corrector with the aid of certain matrix/die cf the transformation of wave amplitudes without a change in the center of resolution[2].

FOOTNOTE [2]. Analytical formulas for the simulation of beam guides with the random transverse shifts/shears of correctors are given in (8-9). ENDFOOTNOTE.

If focal lengths change from one corrector to the next, then in each stage it is necessary to transform base line system, cabling its each time to its corrector (with its distance). This transformation is conducted by the augmented matrix of coupling coefficients.

Thus, for the simulation of separate beam guide is assigned the exciting field, to all heterogeneities are assigned the specific random values (for example, to each corrector it is assigned certain shift/shear) and via translation fields from the corrector to the corrector taking into account known heterogeneities will be determined field at the output of beam guide. Fields at the input, on the intermediate correctors and at the output are assigned by the set/dialing of wave amplitudes and by the coordinate of the center of resolution. The consecutive transformations of these amplitudes are conducted with the aid of the matrices/dies of coupling coefficients. These matrices/dies, generally speaking, are infinite, but the corresponding evaluations/estimates make it possible to replace by their final ones, i.e., to consider a finite number of waves, reaching in this case the preset accuracy. If we require, for example, so that the power of all disregarded on one corrector waves would not exceed 10^{-3} dB, then in the calculations it will participate only 10-15 waves. This makes it possible to simulate during one hour, on a computer of type BESM-2M (8 thousand operations in 1 second), about 100 beam guides, which consist of 100 corrections each.

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USE OF SIMULATION FOR THE ANALYSIS OF IRREGULAR BEAM GUIDES.

We will be restricted here to the examination of beam guides with random transverse displacements of correctors - among all possible heterogeneities the heterogeneities of such type introduce, as a rule, the greatest losses.

On the models of separate beam guides with the displacement is detected the so-called cushioning effect of beam. Fig. 1 schematically depicts the section of certain beam guide. Solid line designated the trajectory of geometric ray/beam; on by shrine trajectory would be propagated the center of beam, correctors were not limited. Due to the finiteness of the correctors (it is assumed that they they are included in the absolutely absorbing diaphragms) the real trajectory of bundle (dotted line) differs from geometric-optical. This divergence it becomes noticeable beginning from that corrector bundle approaches sufficiently closely to the edge, so that the essential part of the energy falls diaphragm. As a result the trajectory of bundle somewhat is smoothed, approaching an axis of beam guide.

For explaining this effect let us present field on each corrector in the form of the superposition of its own waves of beam guide with the substantially limited correctors; reference point consistent with the center of the corrector, on which is conducted the resolution. As has already been mentioned, such waves were determined in the limits of aperture and have different losses, which increase with the number of wave, and, if c is not very small, then the losses of several first waves are negligible. The greater c, the greater the slowly decaying waves.

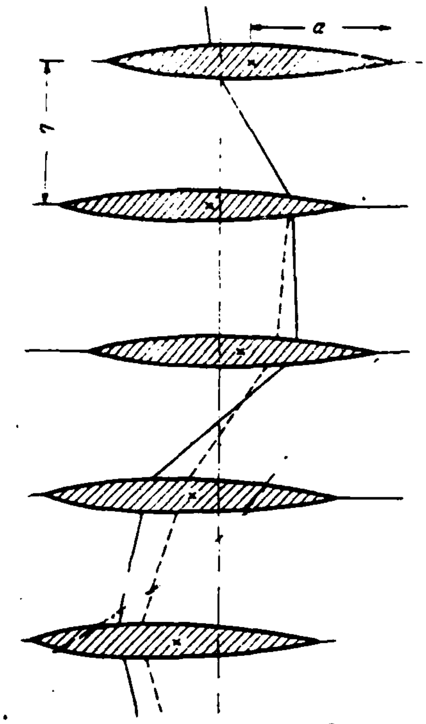

Fig. 1.

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In the process of the propagation of bundle along the irregular beam guide occurs the transformation of its own waves; the removal/distance of beam from the axis of beam guide means that as a result of repeated transformations appear the waves with by ever more fine numbers, and the share of the lowest waves in the bundle falls. Thus far bundle does not approach closely to the edge of corrector, it consists only of the waves whose losses are negligible; beam shape in this case is not distorted, but its trajectory coincides with the geometric-optical. And only with the approach of bundle to the edge in the resolution are developed waves with the noticeable losses, they rapidly attenuate, and as a result in the frame remain only the slowly decaying waves. Due to this bundle it is driven out from the edge of corrector, since in it disappear the waves, which have noticeable amplitude on the edge (and, naturally, noticeable losses), this and there is damping bundle. The damping the more strong, the less the number of Fresnel c; the greatest damping possess the mentioned above one-mode beam guides - in them the trajectory of bundle actually coincides with the line of centers of correctors.

According to the results of the simulation of the statistically uniform ensembles of irregular beam guides it is possible to construct the density curves of the distribution of losses[1]; the typical form of such curves for the beam guides of different length is represented in Fig. 2.

FOOTNOTE [1]. Probability that value P of losses in the concrete/specific/actual beam guide will prove to be interval (P_1, P_2), can be determined on the density of distribution ρ (p) as follows:

$$p(P_1 < P < P_2) = \int_{P_1}^{P_2} \rho(P)\, dP.$$

ENDFOOTNOTE.

In the character of these curves is developed the qualitative difference between the multimode (solid lines) and one-mode (dotted line) beam guides. For the one-mode beam guides the function of density of distribution it has Gaussian form - the most probable values of losses in such beam guides are the values, close to the averages. Probability that the irregular one-mode beam guide will have losses, considerably differ from the averages, is negligibly small. For the multimode beam guides the density of distribution of losses takes, as a rule, the double-humped form. This means that most probable are either the very large or very low losses, and the probability of the appearance of losses, close to the averages, it is comparatively small. In the limit ($c \to \infty$ due to the decrease of wavelength) the bundle in the multimode beam guide degenerates into the infinitely thin ray/beam, and then losses in the beam guide are equal either to 0 (ray/beam reached the end/lead of the beam guide), or 1 (ray/beam on any corrector exceeded the limits of aperture). The average/mean value of losses $\overline{P}$ in this case is equal to the probability of the fact that the ray/beam will not reach the end/lead of the beam guide.

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Density of distribution becomes sum two delta - functions with the appropriate weights

$$\rho(P) = (1-\overline{P})\delta(P) + \overline{P}\delta(1-P)$$

- the limiting case of double-humped distribution.

Random heterogeneities (for example, the transverse displacements of correctors) will appear and change in the time even in the initially well adjusted beam guide. From this point of view the double-peaking of the density curves of distribution means that the significant part of the time the beam guide will work with the large losses. If we consider also that the presence of large losses in the multimode beam guide unavoidably entails the strong distortion of shape of beam (these losses they can appear only on leaving of the part of the bundle beyond the limits of the aperture of what - first corrector), then will become obvious the undesirability of double-humped distribution. In order to decrease the probability of the appearance of large losses, it is necessary to make a trajectory of the bundle of of smoother, without making it possible for it to approach edges of correctors. By one of the methods to achieve this is the use of long-focus correctors. As is known, the degree of a change in the trajectory of geometric ray/beam by the shifted corrector the less, the greater the focal length of corrector. On the other hand, in the beam guides with the long-focus correctors are formed/shaped broader beams and, therefore, in them and the damping is more strong. True, focal length cannot be increased infinitely; finally, bundle is expanded so, that appear the large losses on each corrector. Naturally appears the task about the optimum focal length (for example, in the sense of the minimum of the average/mean value of losses). The solution of this problem can be obtained, by simulating the ensembles of beam guides and by comparing the averaged results for different focal lengths. Optimum focal length depends on the root-mean-square value of shift/shear Δ (Fig. 3)[1].

FOOTNOTE [1]. The results of Fig. 3 are more precise than gives formula (23) in [9]. ENDFOOTNOTE.

It turned out that the optimum in sense indicated above beam guides possess the very important property: in them the density function of the distribution of losses, as a rule, Gauss-like, i.e., losses in the concrete/specific/actual realizations of such beam guides are close to the averages.

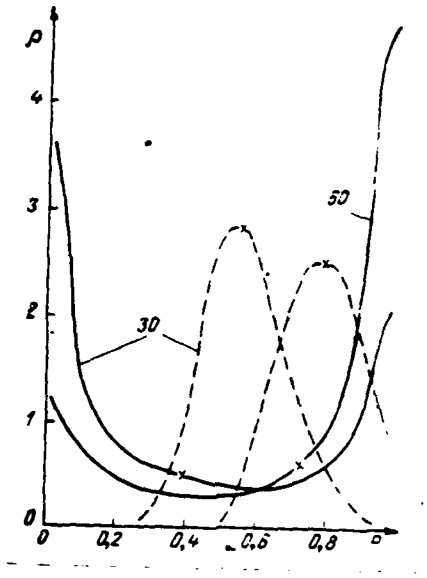

Fig. 2.

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This fact, together with the sufficiently low level of average/mean losses (order 15o/o to 100 correctors with c=25 and Δ=0.1 a), shows the advisability of the search for optimum focal lengths.

However, on the series/row of technical reasons production and use of long-focus correctors proves to be sometimes difficult. Moreover, the dependence of optimum focal length from Δ requires the preliminary knowledge of the average value of displacement by which can be subjected the correctors; and this is not always possible. There are other reasons, which make it necessary to search for other ways of decreasing the losses in the irregular beam guide. One of such paths it is possible to consider the automatic tuning of separate correctors, for example the introduction through the specific cuts of the beam guide of the artificial displacement of correctors, calculated so that they would bring the trajectory of bundle closer to axis. For the simulation of beam guides with the self-alignment it is necessary to consider the additional losses, unavoidable with that or other method of tuning, and also possible in this case error. Since all this depends on the concrete/specific/actual schematic of tuning and technical equipment, its realizing, we will be restricted for the illustrative targets to the idealized case, namely, let us suppose that several correctors bundle are derived/concluded to the axis by the displacement of two adjacent correctors and to the additional losses in this case they are not introduced. Fig. 4 gives the density of distribution of losses in the confocal beam guides of different length with the tuning through 10 correctors.

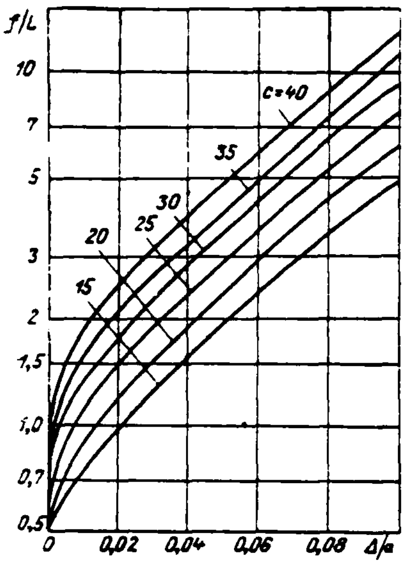

Fig. 3.

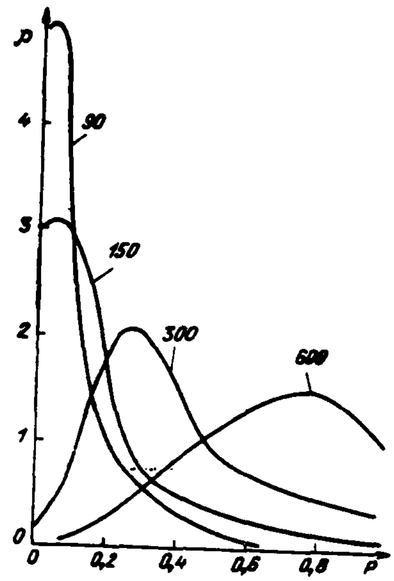

Fig. 4.

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Curves correspond to Fresnal's parameter c=25 and root-mean-square value of shifts/shears Δ=0.08 a. As it follows from the given curves, with the aid of the self-alignment it is possible to considerably lower the level of losses even in the very long beam guides (order - several hundred correctors); in this case the distribution of losses around their average/mean value proves to be very dense.

We gave only some results of those which can be obtained by the simulation of beam guides on the computer(s) (and, apparently, inaccessible or, at least, poorly accessible when other methods are used). By this method it is possible to investigate beam guides with different means of heterogeneities. In particular, there is great interest in the study of beam guides with the correlated heterogeneities, for example, beam guide with the random curves of axis. Preliminary simulation will bring the specific benefit also during the layout of real routes.

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ONE USE OF METHODS OF THE STATISTICAL THEORY OF ANTENNAS.

G. S. Bogoslovskiy, V. A. Usin.

Are examined questions of the use of methods and the apparatus for the statistical theory of antennas for determining the statistical characteristics of the "noise" of transparent dielectric films. Are given the experimental results, obtained during the investigation of the photographic films of some types.

FORMULATION OF THE PROBLEM.

The question about the determination of the statistics of the "noise" of transparent dielectric films arises, for example, in connection with the fact that at present frequently they resort to the recording of information on the photographic materials of different forms (films, plates, etc.). So they enter, for example, in the holography, with the mapping of the earth's surface with the aid of the locators of lateral survey/coverage with the synthesized aparture and in a number of other cases. General/common/total in this case is need for recording and playback of information not only about the amplitude, but also about the phase of the fixed/recorded process. The latter will be always distorted due to the "noise" of the photographic material, which appears as a result of inaccuracies in its profile/airfoil, that appear in the process of production. The "noise" of dielectric film, naturally, will determine the potential characteristics of the systems, in which the photographic material is the data carrier, and to distort this information.

The statistics of rough screens - namely, such is film - frequently characterized by dispersion and by a radius of the correlation of distortions. We will also consider that for the quantitative evaluation of the degree of the distortion of information it is necessary to determine, first of all, σ^2 and ρ of the "noise" of photographic material.

Is given below one of the possible methods of solving stated problem. Only method consists of the following. Coherent light wave is passed through the film. By this distorted wave they irradiate the opening/aperture of known geometric form. Information about σ^2 and ρ of "noise" of film is obtained, analyzing diffraction pattern from the opening/aperture.

DESCRIPTION OF METHOD.

Let opening/aperture in the opaque screen - square with side L - they irradiate by the plane wave of coherent light/world, which falls normal to screen.

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Wave processes in this system are described in accordance with Huygens-Kirchhoff's principle by the integral

$$E(M)=\frac{i\kappa}{2\pi}\int_S E_S\frac{e^{-i\kappa R}}{R}ds, \qquad (1)$$

where E_S - value of field E on surface of S,

$\kappa=2\pi/\lambda$ - wave number,

R - distance between element/cell ds of surface S and point observation M, in which is searched for field E.

Examining problem in the approximation/approach of Kirchhoff, making common for a remote zone assumptions and omitting unessential for analysis constant factors, let us rewrite (1) in the form

$$I_0(\psi, \psi_1) = \int_{-1}^{1}\int A(x, y)\, e^{i\psi x + i\psi_1 y}\, dx\, dy =$$

$$= A_0 \int_{-\infty}^{\infty}\int [u(x+1) - u(x-1)][u(y+1) - u(y-1)]\, e^{i\psi x + i\psi_1 y}\, dx\, dy. \quad (2)$$

Here A_0 - amplitude of the incident to the opening/aperture wave,

$$u(z) = \left\{ \begin{matrix} 1 & \text{при (1)} & z > 0, \\ \frac{1}{2} & \text{при (1)} & z = 0, \\ 0 & \text{при (1)} & z < 0 \end{matrix} \right\} - \text{единичная функция (2).}$$

Key: (1). with. (2). unit function.

$\psi = \frac{\pi L}{\lambda}\sin\theta$, $\psi_1 = \frac{\pi L}{\lambda}\sin\Phi$ - the generalized angles; $x=2x'/L$, $y=2y'/L$ - reduced coordinates in the plane of opening/aperture [1].

FOOTNOTE [1]. The reference pcint cf coordinates corresponds to the center cf opening/aperture. ENDFOOTNOTE.

After placing in the remcte zone of opening/aperture recorder, let us fix the distribution of the intensity of light in the diffraction pattern

$$|I_0(\psi,\ \psi_1)|^2 = A_0^2 \iiiint\limits_{-\infty}^{\infty} [u(x+l) - u(x-l)]\,[u(x_1+l) - u(x_1-l)]\,[u(y+l) - u(y-l)]\,[u(y_1+l) - u(y_1-l)]\, e^{i\psi(x-x_1) + i\psi_1(y-y_1)} dx\, dx_1\, dy\, dy_1. \quad (3)$$

This distribution contains information about the size/dimension of opening/aperture L.

Let us assume now that the incident wave passes preliminarily through the transparent optical heterogeneity - photographic film. Let us assume that it does not change amplitude distribution, but introduces as a result of the heterogeneity of thickness the random phase displacement $\phi(x, y)$ into the transmitted wave.

The distribution of intensity for this realization of random process $\phi(x, y)$ takes the following form:

$$|I(\psi,\ \psi_1)|^2 = A_0^2 \iiiint\limits_{-\infty}^{\infty} [u(x+l) - u(x-l)]\,[u(x_1+l) - u(x_1-l)] \times [u(y+l) - u(y-l)]\,[u(y_1+l) - u(y_1-l)] \times e^{i[\varphi(x,y) - \varphi(x_1,y_1)]} e^{i[\psi(x-x_1) + \psi_1(y-y_1)]} dx\, dx_1\, dy\, dy_1. \quad (4)$$

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In distribution (4) is contained, obviously, the information not only about the sizes/dimensions of opening/aperture, but also about the parameters of the optical heterogeneity, which caused random phase shift.

If we average (4) on the ensemble of realizations $\varphi(x, y)$, then it is possible to obtain the information already about the statistical characteristics of the "noise" of film. The corresponding distribution of intensity takes the form

$$\overline{|I(\psi, \psi_1)|^2} = A_0^2 \iiiint\limits_{-\infty}^{\infty} [u(x+1) - u(x-1)][u(x_1+1) - u(x_1-1)] \times$$
$$\times [u(y+1) - u(y-1)][u(y_1+1) - u(y_1-1)] \times$$
$$\times e^{\overline{i[\varphi(x, y) - \varphi(x_1, y_1)]}} e^{i[\psi(x-x_1) + \psi_1(y-y_1)]} dx\, dx_1\, dy\, dy_1. \qquad (5)$$

Let us note that relationship/ratio (5) is analogous with the appropriate formulas of the statistical theory of antennas [1, 2]. This will allow us subsequently to use some results of work [2].

From the distribution of intensity (5) it is possible to already extract information about the interesting to us parameters σ^2 and ρ, as this was done, for example, in [2]. Actually/really, in the statistical theory of antennas [1, 2] are designed average/mean radiation patterns for the sufficiently large range σ^2 and ρ. Comparing with them the experimentally specific distributions of intensity $\overline{|I(\psi, \psi_1)|^2}$, it is possible with the specific degree of accuracy to rate/estimate these parameters. One should immediately be specified that with this method of determination σ^2 and ρ [3] are utilized the a priori assumptions about the form of the correlation coefficient. While conducting calculations in [1, 2] this form was assumed to be exponential or Gaussian. Although it is possible to assume that for the monotonically collapsible/dropped correlation coefficients the results will be similar, at least qualitatively [2], it is of interest to examine the methods of determination of σ^2 and ρ, which do not require the a priori assumptions indicated.

We will use for this expression (5). Converting it according to Fourier, we will obtain

$$F[\overline{|I(\psi,\ \psi_1)|^2}] = \int\limits_{-\infty}^{\infty}\int \overline{|I(\psi,\ \psi_1)|^2}\, e^{-i\psi\nu - i\psi_1\mu}\, d\psi\, d\psi_1 =$$

$$= A_0^2 \int\int\int\limits_{-\infty}^{\infty}\int\int\int [u(x+1) - u(x-1)][u(x_1+1) - u(x-1)]\times$$

$$\times [u(y+1) - u(y-1)][u(y_1+1) - u(y_1+1)]\times$$

$$\overline{e^{i[\varphi(x,\ y) - \varphi(x_1, y_1)]}}\, e^{i[\psi(x - x_1 + \nu) + \psi_1(y - y_1 - \mu)]}\, dx\, dx_1\, dy\, dy_1\, d\psi\, d\psi_1. \quad (6)$$

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After changing the order of integration in (6), let us calculate at first

$$\int\limits_{-\infty}^{\infty}\int e^{i\psi(x - x_1) - \nu)}\, e^{i\psi_1(y - y_1 - \mu)}\, d\psi\, d\psi_1 = \delta(x - x_1 - \nu)\, \delta(y - y_1 - \mu).$$

and then, after using the filtering property of δ-function and after replacing the variable/alternating

$$x_1 = x - \nu, \quad y_1 = y - \mu,$$

let us rewrite expression (6) in the form

$$F[\overline{|I(\psi, \psi_1)|^2}] = A_0^2 \int\int_{-\infty}^{\infty} [u(x+1) - u(x-1)][u(x-\nu+1) - (x-\nu-1)] \times$$
$$\times [u(y+1) - u(y-1)][u(y-\mu+1) - u(y-\mu-1)] \times$$
$$\times e^{\overline{i[\varphi(x,y) - \varphi(x-\nu, y-\mu)]}} dx\,dy. \quad (7)$$

For the computation in integral in the right side of expression (7) it is necessary to make the specific assumptions relative to random process $\phi(x,y)$. Let us assume that $\phi(x,y)$ - two-dimensional normal stationary random process with the zero average. This assumption is logical in connection with the fact that in view of the variety of the factors, which operate on the film in the process of its production, must be fulfilled the central limit theorem.

Under these assumptions we will use for computing the integral in right side (7) expression for the characteristic function of a difference in random variables [4]. Then we obtain

$$F[\overline{|I(\psi, \psi_1)|^2}] = A_0^2 \int\int_{-\infty}^{\infty} [u(x+1) - u(x-1)][u(x-\nu+1) - u(x-\nu-1)] \times$$
$$\times [u(y+1) - u(y-1)][u(y-\mu+1) - u(y-\mu-1)] e^{-\sigma^2[1-r(\nu,\mu)]} \times$$
$$\times dx\,dy = A_0^2 \Delta(\nu) \Delta(\mu) e^{-\sigma^2[1-r(\nu,\mu)]}. \quad (8)$$

Here

$$\Delta(\tau)=\begin{cases}1+\frac{\tau}{2} \text{ при}^{(1)} -2\leqslant\tau\leqslant 0,\\ 1-\frac{\tau}{2} \text{ при } 0\leqslant\tau\leqslant 2,\\ 0 \text{ при остальных}^{(2)}\ \tau,\end{cases}$$

Key: (1) with. (2) with remaining τ.

$\sigma^2=\sigma_x^2=\sigma_y^2$ — the dispersion of random process $\phi(x,y)$,

$r(\nu,\mu)$ — the coefficient of correlation of random process $\phi(x,y)$.

After taking the logarithm of relationship/ratio (8), and also converting expression (3) analogous with (5), let us record

$$\ln F[\overline{|I(\psi,\psi_1)|^2}]=\ln[A_0^2\Delta(\nu)\Delta(\mu)]-\sigma^2[1-r(\nu,\mu)], \tag{9}$$

$$\ln F[|I_0(\psi,\psi_1)|^2]=\ln[A_0^2\Delta(\nu)\Delta(\mu)]. \tag{10}$$

Deducting (9) from (10), we will obtain

$$\ln F[|I_0(\psi,\psi_1)|^2]-\ln F[\overline{|I(\psi,\psi_1)|^2}]=\sigma^2[1-r(\nu,\mu)]. \tag{11}$$

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In (11) is contained all information about the correlation function of random process $\phi(x, y)$. Bearing in mind, that $r(\nu,\mu)$ vanishes when $\nu,\mu\to\infty$, it is possible from (11) to determine dispersion, and then the radius of the correlation of errors at the assigned level.

After measuring $|I_0(\psi, \psi_1|^2$ and $\overline{|I(\psi, \psi_1)|^2}$, it is possible to realize algorithm (11) with the aid of computer(s) or with the aid of electro-optical circuits.

In both cases it is necessary to, first of all, measure the averaged distribution of intensity $\overline{|I(\psi, \psi_1|^2}$. Let us examine one of the possible methods of this measurement.

Experimental determination $\overline{|I(\psi,\psi_1)|^2}$. Evaluation/estimate of the parameters of the "noise" of film.

For experimental determination $\overline{|I(\psi, \psi_1)|^2}$ was utilized the installation whose schematic was given in Fig. 1.

As the source of coherent light 1 was utilized the laser in the one-mode mode/conditions. The parameters of ray/beam at the output of collimator 2 and installation were selected so that the distribution of light/world in the limits of opening/aperture in opaque screen 6 would be uniform.

Recording image was conducted by photometric method. The distribution of light/world in the diffraction pattern they photographed by mirror camera 7 (type "Zenit"), located in the focal plane of converting lens 6. The obtained image they scanned photometrically on the recording microphotometer MF-4.

During recording of distribution $|I_0(\psi, \psi_1)|^2$ (Fig. 2a) the film 3 (Fig. 1) being investigated they removed from the path of ray/beam. During the arrangement/position with the path of the ray/beam of the motionless film being investigated they recorded the "instantaneous" distribution of intensity (Fig. 2b, c). For recording the averaged distribution $\overline{|I(\psi, \psi_1)|^2}$ the sample/specimen of the film 3 being investigated they revolved with the aid of electrical micromotor 4 (Fig. 1). The visually observed effect of averaging is illustrated by Fig. 2d. The obtained as a result of photometric measurement graphs/curves compared with the calculated ones and according to the results of comparison were rated/estimated values of σ^2 and ρ.

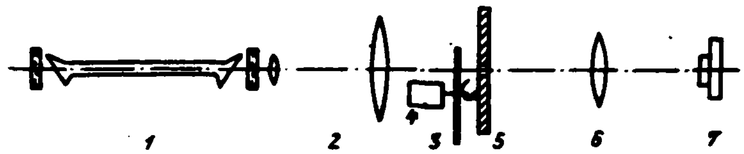

Fig. 1

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In connection with the fact that the calculations were carried out for principal planes of square aperture, for the comparison with them were utilized experimental curves $|I(0,\psi_1)|^2$ cr $|I(\psi,0)|^2$.

Before passing to the discussion of experimental results, it is necessary to note the following. The value of the linear section characteristic curve recording photographic film is insufficient so that to it they would hit the main and minor lobes of distribution $|I(\psi,\psi_1)|^2$. Therefore photography it is necessary to produce several times with different exposures, and then "to join" the obtained results. Exposure can be changed, changing value of luminous flux with the aid of calibrated optical filters [4] or changing the time of exhibition. As the standard for the construction characteristic curve recording photographic film was utilized well known distribution $|I_0(\psi,\psi_1)|^2$ for the square opening/aperture.

Accuracy of measurements by ~10o/o with a drop/jump in the intensities of 20-25 dB.

Were measured distributions $\overline{|I(\psi, \psi_1)|^2}$ for the support/base of a film of the type "Mikrat 300". Measurements were made for the square openings/apertures with sides L=0.15; 0.25; 0.30 mm. The set/dialing of openings/apertures was utilized on the following reasons. Values of σ^2 and ρ are determined by the data by the sample/specimen of film. However, calculated curves $\overline{|I(\psi, 0)|^2}$ $(\overline{|I(0, \psi_1)|^2})$ are constructed for the set/dialing of values σ^2 and relative radius of correlation $c=2\rho/L$. It means, changing L, we obtain the possibility to rate/estimate the "stability" of experimental results, i.e., to judge how is justifiable the use of calculated curves, constructed under the specific assumptions about the form of the correlation coefficient, for the evaluation/estimate of σ^2 and ρ. The legitimacy of such assumptions can be confirmed by the coincidence of the evaluations/estimates of σ^2 and ρ, obtained in the measurements with the openings/apertures of different sizes/dimensions.

The results of experiment are illustrated by the graphs/curves of Fig. 3a, b, c for the square openings/apertures with L=0.15; 0.25; 0.3 mm respectively. On all graphs/curves are plotted/applied experimentally taken/removed distributions $\overline{|I(\psi, 0)|^2}$ (by small circles), and also calculated curves, constructed for the values σ^2=0.2, c=4, 6, 8 for the exponential form of the coefficient of correlation (broken lines).

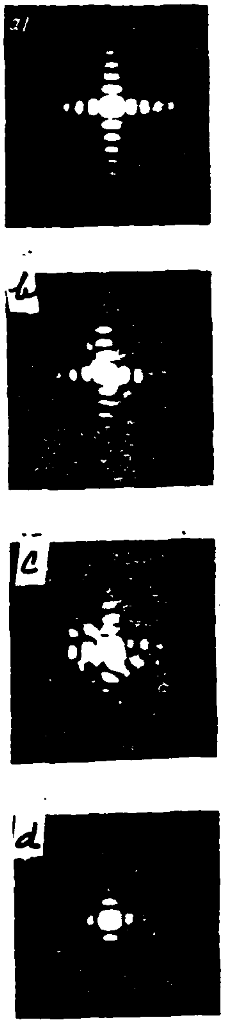

Fig. 2.

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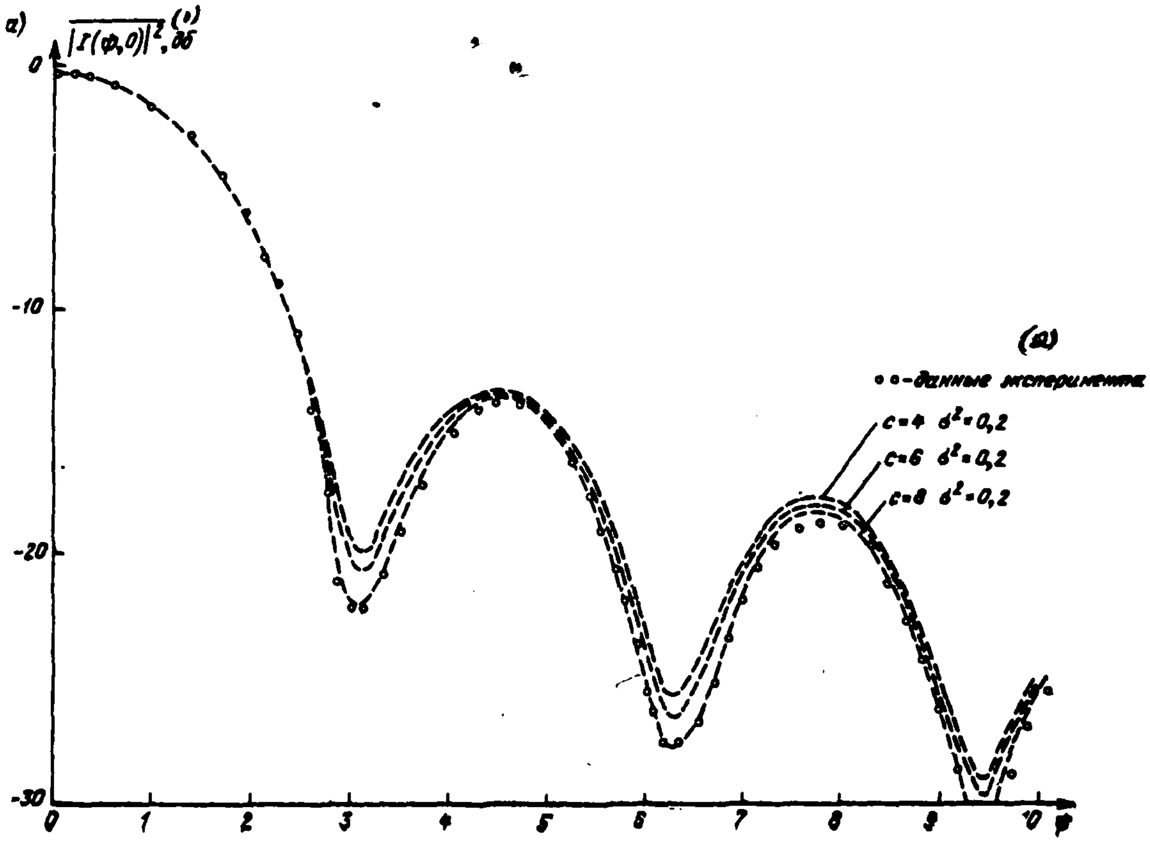

Fig. 3.a.

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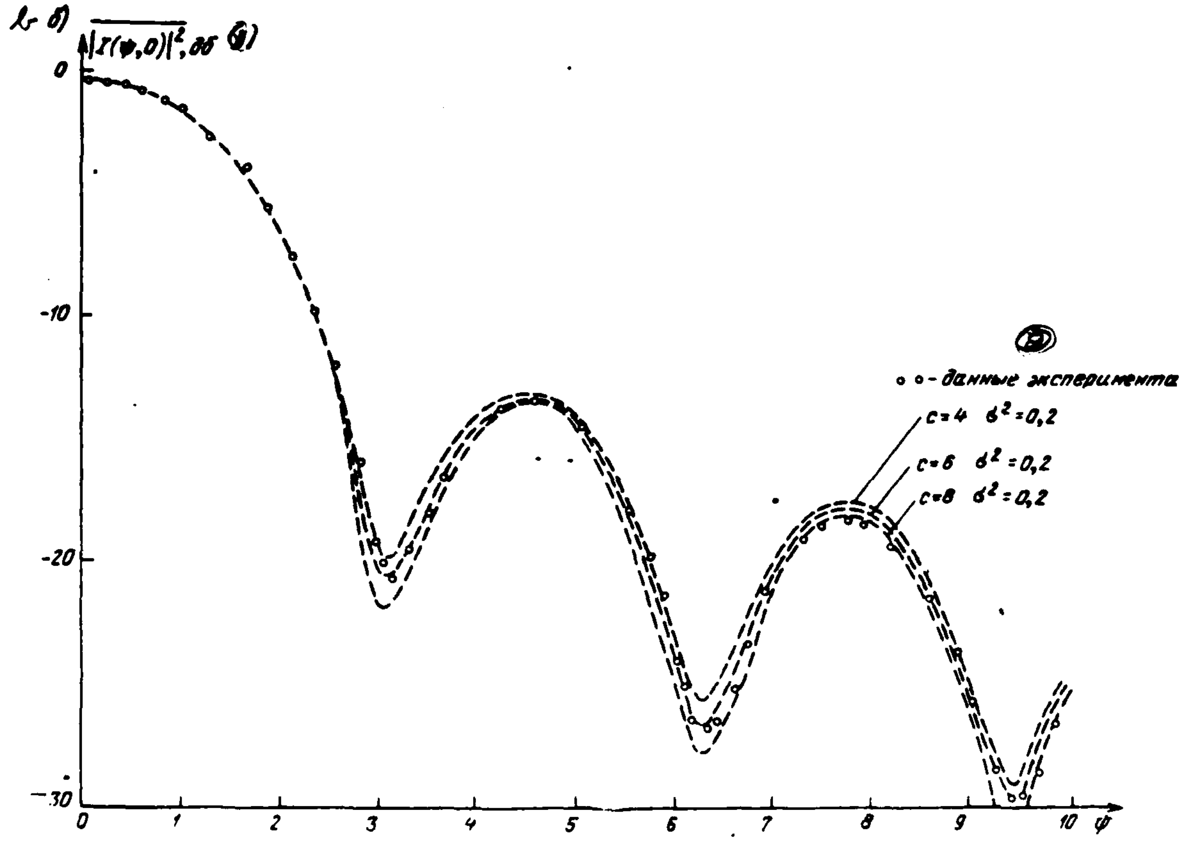

Fig. 3.b.

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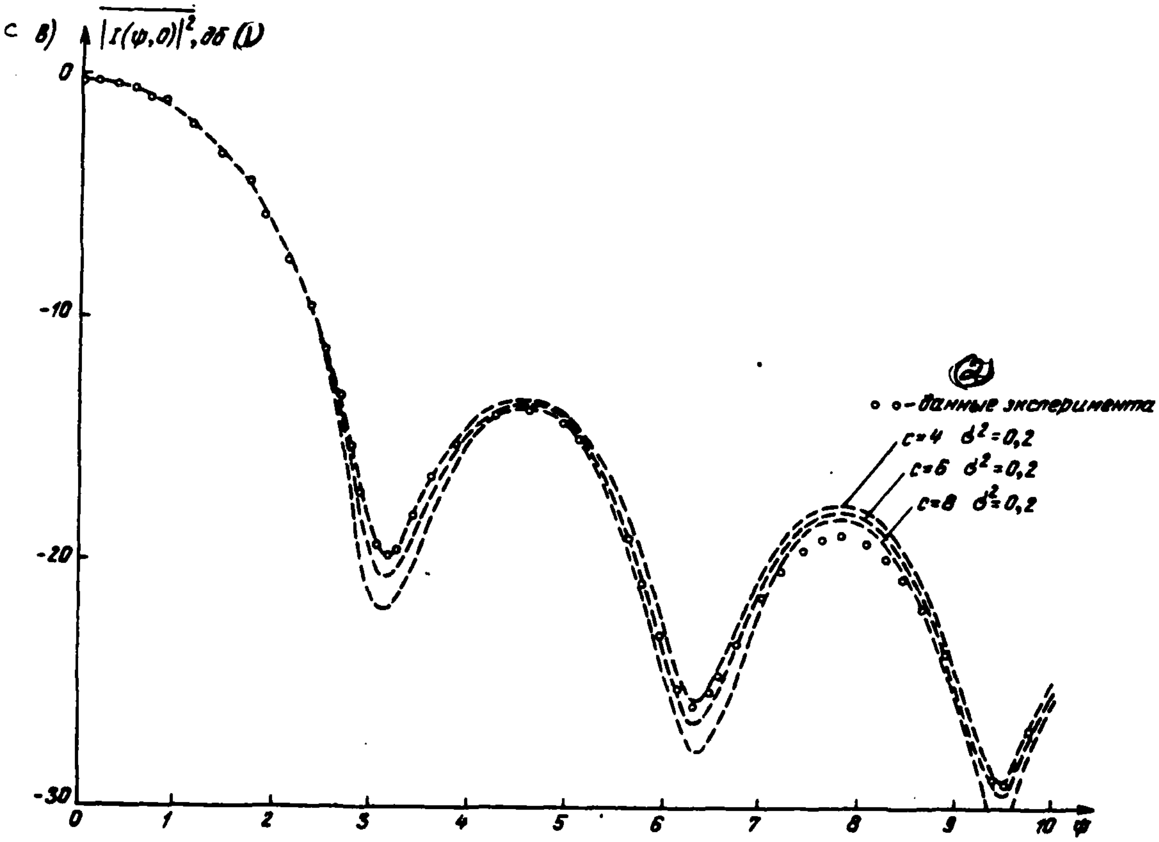

Fig. 3.c.

Key: (1) dB. (2) data of experiment.

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Calculated curves for the Gaussian form of the correlation coefficient qualitatively differ little from those constructed. From the figures evidently, the obtained results qualitatively confirm the positions of the statistical theory of antennas [1, 2] about the character of the distortions of average/mean radiation pattern (average/mean diffraction pattern).

From the analyses of the obtained results it is possible to establish/install the following:

1. Statistical characteristics of the "noise" of the investigated film, obtained via comparison with calculated curves, are rated/estimated by the following values:

a) for the exponential form of the correlation coefficient:

$$L = 0{,}15\ \textit{мм}:\quad \sigma^2 \approx 0{,}2,\quad c \approx 8\quad (\rho \approx 0{,}6\ \textit{мм});$$
$$L = 0{,}25\ \textit{мм}:\quad \sigma^2 \approx 0{,}2,\quad c \approx 5{,}6\quad (\rho \approx 0{,}7\ \textit{мм});$$
$$L = 0{,}30\ \textit{мм}:\quad \sigma^2 \approx 0{,}2,\quad c \approx 4\quad (\rho \approx 0{,}6\ \textit{мм});$$

b) for the Gaussian form of the correlation coefficient:

$$L = 0{,}15\ \textit{мм}:\quad \sigma^2 \approx 0{,}3,\quad c \approx 5{,}4\quad (\rho \approx 0{,}40\ \textit{мм});$$
$$L = 0{,}25\ \textit{мм}:\quad \sigma^2 \approx 0{,}3,\quad c \approx 3{,}5\quad (\rho \approx 0{,}45\ \textit{мм});$$
$$L = 0{,}30\ \textit{мм}:\quad \sigma^2 \approx 0{,}3,\quad c \approx 2{,}6\quad (\rho \approx 0{,}40\ \textit{мм}).$$

2. Results of measurements strongly do not depend on the

size/dimension of the utilized opening/aperture, and the latter can be selected from the conditions of convenience in the experimentation.

3. Estimates of the magnitude of σ^2 and ρ, obtained for the different form of the correlation coefficient, have one order, but they depend on the form of the correlation coefficient. Therefore to more preferably utilize such methods of the evaluations/estimates, in which is not required a priori assumptions about the form of the correlation coefficient.

In conclusion the authors consider it their pleasant duty to express appreciation to professor Ya. S. Shifrin for the management/manual of this work and V. I. Zamyatina for the participation in her discussion.

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DIRECTED DIVIDERS ON THE METAL-DIELECTRIC WAVEGUIDES.

V. P. Dubrovin, D. I. Mirovitskiy, L. S. Osipov.

In the article are presented the results of developing the structurally/constructurally simple directed dividers of power SVCh on the metal-dielectric waveguides in which the use of new principle of beam communication ensured high electrical characteristics in the broadband. The production of dividers in the series production is realized by methods of printed technology.

For the two-channel directed divider of power in the centimeter wave band are given fundamental electrical and structural/design characteristics.

With each year to the lines of transmission of energy SVCh are presented all new, often opposite, the requirements. Here and the requirement of the decrease of sizes of cross section (in the decimeter range), and, on the contrary, their increase (in the range of millimeter and submillimeter waves), the requirement of low losses, good screening from the environment and the at the same time convenient access into the internal cavity of waveguide. Especially urgent are problems the broad-band character of the waveguide lines of transmission (and also nodes on their basis) and transmission of large power SVCh.

None of the known transmission lines satisfies to that enumerated, in many respects contradictory, to requirements, and therefore are natural the constant searches for the new types of lines and development for different functional units, which satisfy at least partially these requirements.

One of the promising lines of transmission, proposed by Tusher [1] and that investigated by a number of the authors [2-4], is H-shaped metal-dielectric waveguide (Fig. 1).

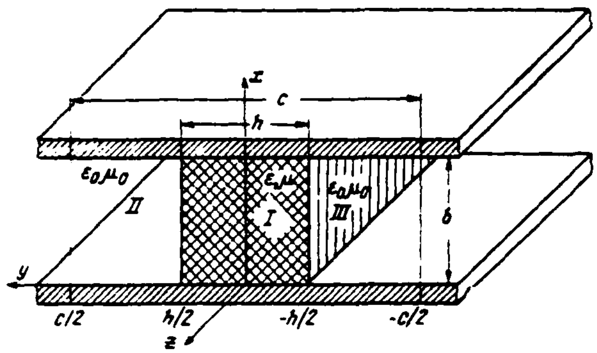

Fig. 1.

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Fundamental lowest vibration mode is here symmetrical $H_{01}(LE_{01})$ wave. The special feature/peculiarity of this wave it is "cutoff" with any sizes/dimensions of waveguide. During the use of dielectrics with the large dielectric permeability (for example, ceramics of titanates of calcium and strontium $\varepsilon \sim 100-150$ and $tg\delta \approx 6 \cdot 10^{-4}$), this waveguide is suitable for the uses/applications the lowest frequencies SVCh of range. In work [5] shown that at the frequency of 1 GHz with identical sizes/dimensions of the cross section of a H- waveguide and track the linin, filled with a dielectric of the type Rexolite ($\varepsilon \approx 2.54$;

$tg\delta\approx5.10^{-4}$), the first possesses the considerably larger capacity (2 mW; 50 kW of peak. In this case the longitudinal sizes/dimensions of elements/cells and nodes on a H- waveguide prove to be several times of less than the sizes/dimensions of the corresponding nodes on the strip line, and linear energy losses (to the wavelength) descend 2-2.5 times.

On the other hand, in [3] it was indicated the advisability of using H- waveguides on the millimeter and submillimeter waves with others lowest of oscillation/vibration (by wave LM_{11}). On this wave (with the exception/elimination of the highest vibration modes) are obtained the maximum sizes of the cross section of a H- waveguide. This leads to the low losses and the possibility to canalize high power levels SVCh. The character of a change in the losses with the frequency here is anomalous (losses decrease with an increase in the frequency), is the same as in the circular waveguide with H_{01} by wave. The absence of longitudinal ones is such in the metallic walls of H- waveguides with LM_{11} by wave it simplifies their mating.

The enumerated positive special features/peculiarities of a H-waveguide were occasion for the beginning of the investigation of the series/row of broadband nodes and elements/cells on its base, most frequently utilized in the technology SVCh, these as two - and multichannel directed dividers of power, the directional couplers, the hybrid and rotating joints, different filters, detector caps, etc. In the present work are described the results of developing the two-channel directed divider of power on the metal-dielectric waveguide.

EXCITATION OF METAL-DIELECTRIC WAVEGUIDE.

Fundamental wave H_{01} in the metal-dielectric waveguide is most simply excited by rectangular waveguide with wave H_{10} (upon their coaxial inclusion/connection).

The selection of width h of the dielectric plate of waveguide and its dielectric permeability ε was conducted, on the basis of the following contradictory requirements. On one hand, it followed as far as possible more strong "to connect" electromagnetic field with the dielectric so that in the place of an abrupt change in the boundary conditions (upon transfer from the rectangular metallic waveguide to the metal-dielectric) reflection would be minimum.

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For meeting of this requirement the cross section of the wave tube, in which is localized basic part of transmitted power, must be equal (or it is less), to the cross section of rectangular waveguide. On the other hand, for guaranteeing the directed branching off of power should be ensured the conditions of the weak "connection/communication" of wave with the dielectric strip of line. Each conditions it proved to be possible to ensure during the use of a dielectric of the type CT-5 with $\varepsilon=5$ and $tg\delta=6.10^{-4}$, if we select strip with a width of h=4 mm. It was taken into consideration, besides the fact that for the waveguide of the conventional section 10x23 mm^2 there is a standard transition in the section 4x23 mm^2. As a result of the independence of the fields of wave H_{01} from coordinate x, height/altitude b of metal-dielectric waveguide it proved to be possible for convenience in the coupling to also take as equal to 4 mm. Thus, as a result of calculations and experiments optimum was the square section of dielectric strip (b=h=4 mm). The connection of metal-dielectric and metallic waveguides was realized by the standard collars, shown in Fig. 2, where was depicted the general view of the developed two-channel directed divider. The converter of a H_{10}-wave of metallic waveguide into a H_{01}- wave of metal-dielectric waveguide was made in the form of dielectric key with a length of l (being the continuation of dielectric strip), introduced into the metallic waveguide.

During the arrangement/position along the axis of the metallic waveguide of the selected dielectric strip (h=b=4 mm, ε=5) the field is concentrated it, and on side metallic walls - it is very small. This made it possible without the essential reflections to transmit signal from the rectangular into the metal-dielectric waveguide, in spite of the sharp break of the walls of waveguide.

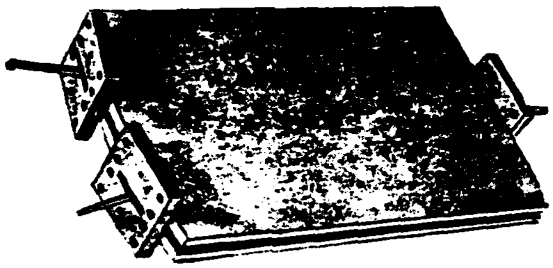

Fig. 2.

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The results of measurement of KSVN [VSWR] in the band of frequencies of 7.5-10.5 GHz (Δf=+-16.5o/o) are given in Table 1 for several lengths of wedge-shaped adapter. Let us note that $KCBH_{макс}$ was observed on the low-frequency edge of working wave band. This is explained in essence by the decrease (with a decrease in the frequency) of transverse wave number in region I (Fig. 1), i.e., in the dielectric strip, and therefore by an increase in the cross section of "wave tube". The latter leads tc an increase in the rcle of the reflections of the part of the energy of the section of the sharp break of side walls in the exciting metallic waveguide.

Relative decrease with an increase in the wavelength of the evenness of tapered matcher plays smaller role, which tale is confirmed experiments with the matching keys for which, in spite of an increase in length l in more than 50 mm, the value of VSWR does not decrease.

COPHASAL DIRECTED BRANCHING OF ELECTROMAGNETIC ENERGY IN DIELECTRIC WAVEGUIDES

During the investigation of the propagation of the deferred-action electromagnetic waves in the connected dielectric waveguides is experimentally discovered [6, 7] the presence of the cophasal directed branching of electromagnetic energy into the lateral circuit, which intersects at sharp angle with the fundamental dielectric waveguide. Are established/installed the following special features/peculiarities of a similar local connection/communication of two dielectric waveguides.

The effective directed branching of energy from the fundamental circuit in the lateral (with the decoupling of arms on the order of 40 dB) is retained in the broadband (+-20o/o) despite the fact that the section of interaction has the limited length (less λ_0).

The branched into the lateral circuit wave is cophasal with the wave, which is propagated in the fundamental circuit.

The discovered effective branching of energy (i.e. with the "pumping" to 50% the energy into the lateral circuit) occurs with the low reflection coefficients in the region of the branching of waveguides from the side cf all four arms of this connection.

The qualitatively cophasal directed branching of electromagnetic energy in two intersecting dielectric waveguides can be explained as follows.

Table 1.

(1) Длина клина l, мм	30	40	50
$КСВН_{макс}$ (2) в полосе	1,53	1,27	1,12

Key: (1). Length of key l, mm. (2). in band.

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In the section of their intersection occurs a change in the guides of the properties of fundamental waveguide, and this local disturbance/perturbation leads to directional radiation of the part of energy from the fundamental waveguide to the side, which "is seized" by the waveguide of lateral circuit and further by it it is transmitted.

Taking into account wave structures H_{01} in the metal-dielectric waveguide and dipole type wave in the dielectric waveguide, it was possible to expect the presence of this type of interaction, also, in the intersecting at angle metal-dielectric waveguides. Therefore was realized the development of the directed divider on the line of Tischer with the use of the described above phenomenon.

TWO-CHANNEL DIRECTED DIVIDER CF POWER.

Three-leg of the divider of power SVCh (for example, Y- and T-shaped dividers on the coaxial line or rectangular waveguide) are not directed, the output arms of dividers are not electrically isolated/insulated from each other. Experiment of the development of such dividers on the dielectric waveguides showed [8, 9], that dipole type wave is transmitted well (in the place of the branching off of fundamental waveguide) only by b those arms which are deflected from the fundamental waveguide at small angle. In the arms, deflected from the fundamental circuit at angle of 90° and more, wave virtually dces not pass. However, for the series/row of uses/applications (fulfillment of diagram by printed wiring, work in the long-wave section of centimeter band) dielectric waveguides are less adapted than metal-dielectric. Therefore was carried out the development of a Y- directed divider also on the metal-dielectric waveguide.

The schematic of a Y- divider of power is shown in Fig. 3. During the supplying of signal into arm 1, power (if angle 2α between arms 2 and 3 it is small) it is divided in half in the region of the symmetrical branching off of metal-dielectric waveguide.

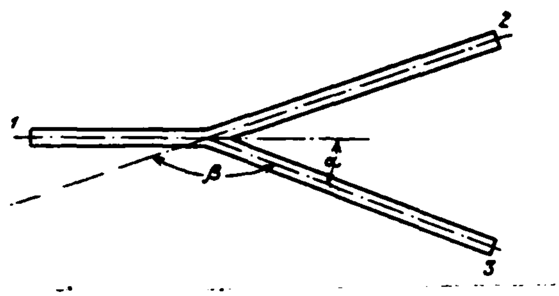

Fig. 3.

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Since branching off smooth and the wave is not too "strongly" connected with the dielectric, it was to be expected that (as in the dividers on the dielectric waveguides the condition of the smallness of the reflection of energy in the region of branching off is satisfied, and consequently, occurs the directed division of power. During the supplying of signal into arm 2 part of the power (approximately/exemplarily half) the force of reciprocity must hit arm 1: The remaining power partially will be emitted in the direction, close to the direction of the axis of arm 2, and partially it will be reflected from the heterogeneity in the region of branching off and will appear into arm 3. Taking into account that the angle β between arms 2 and 3 is great, it was to be expected the negligibly small (in comparison with the primary power, the subject into arm 2) branching of power into arm 3. Thus, arms 2 and 3 dividers must be isolated/insulated from each other. Similar pattern by the force of the symmetry of divider must occur, also, during the supplying to power into arm 3.

The degree of the isolation of lateral arms 2 and 3 from each other depends, naturally, and on their agreement with the output circuits. Thus, during the supplying of signal into arm 2 (if we disregard/neglect the disturbance/perturbation of the wave of the region of branching off, which is correct with the "weak connectedness" of wave with the dielectric strip) the account of the agreement of arm 2 with the output circuit gives the following obvious expression of the maximally attainable insulation between arms 2 and 3:

$$u = 10\lg[2(\sigma+1)(\sigma-1)^{-1}]^2,\ dB.$$

Here σ - VSWR in the waveguide of arm 1 from the side of arm 2.

Thus, for obtaining the directed division with the insulation it is more than 30 dB between arms 2 and 3 it is necessary to apply waveguide transitions with VSWR, at least, not exceeding 1.1. Let us note that the insulation of arms, provided by the discovered phenomenon, substantially above and the actually attainable level of insulation is limited actually by reflection in the arms of branching off. Device/equipment of one of the versions of the developed two-channel divider together with the adapter in the standard section 10x23 mm^2 is shown in Fig. 4.

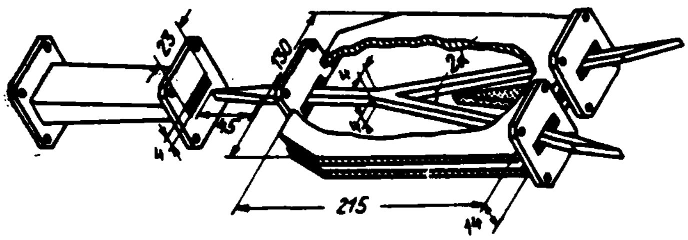

Fig. 4.

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Fig. 5 gives frequency ones the characteristic of the agreement cf all its arms (curves 1, 2, 3, is shcwn change of VSWR in the operating range for lateral arms 1, 2, 3). Are so represented curved 4, which characterizes insulaticn between arms 2 and 3 (obtained with the use/application of the described above adapters from rectangular waveguide to the metal-dielectric). Weakening the signal between arms 1-2 and 1-3 in the range indicated was 4.2+-0.3 dB. Weakening the signal between arms 2-1 and 3-1 was retained within the same limits. Certain increase in the weakening (to 5-5.5 dB) was observed only in the sub-range 7.5-8 GHz. This is caused by the increase here of direct radiation frcm the metal-dielectric waveguide. At the higher emission frequencies from the waveguide again sharply fell. The results of measurements indicate certain disturbance/perturbation of wave near the branch point, since total VSWR at the input of each of three arms exceeded VSWR cf waveguide adapters themselves. Let us note that in the measurement cf VSWR of the arms of divider to its all remaining arms were connected the matched loads on rectangular waveguide with VSWR which do rot exceed 1.05.

For determining its own parameters of the divider of power it was necessary to remove effect or the insulation of the arms of the divider of reflactions from the adapters and the external matchad loads. This was achieved/reached by the introduction of the matched load directly to metal-dielectric waveguide.

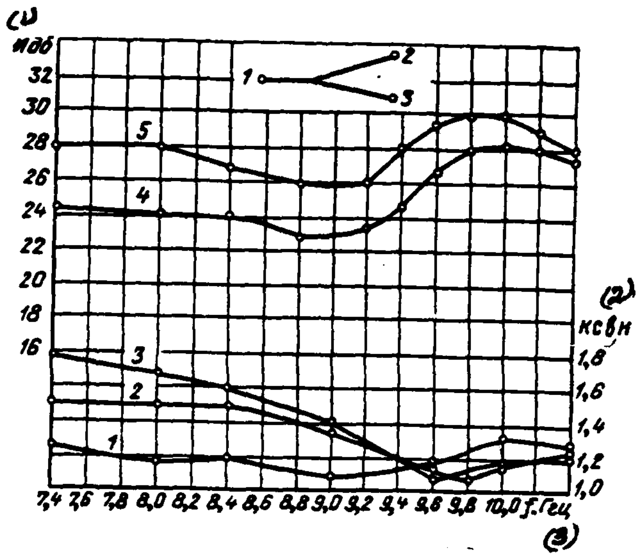

Fig. 5.

Key: (1) dB. (2) VSWR. (3) GHz.

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Load was fulfilled in the form of the keys from the attenuating material of the type M-1, forced against the lateral sides of the dielectric of metal-dielectric waveguide. One of such loads, which ensured VSWR in the range 7-10.5 GHz, not exceeding 1.05, it is shown in Fig. 6. An improvement in the insulation of arms 2 and 3 (upon transfer in arm 1 to the internal matched load is characterized by curved 5 in Fig. 5, which confirmed an essential improvement in this case in the mutual insulation of lateral arms.

As showed investigations, further increase in the insulation of arms blocks the connection/communication of these arms on the diffracted field in the region of transition from the metallic waveguide to the metal-dielectric (i.e. direct leak in this place for energy of one lateral arm into another). For eliminating this connection/communication between arms 2 and 3 into the divider of power was introduced isolating partition from the absorbing material of the type M-1 in the form of key (foundation - 8 mm, height/altitude - 56 mm, thickness - 4 mm), shown in Fig. 4. The exception/elimination of direct connection of arms sharply improved the characteristics of the divider: maximum insulation in the range of will exceeded 46 dB, and minimum increased to 35 dB. In this case total KSWR from arm 1 to the place of the branching off of arms 2 and 3 was below 1.08. During the introduction of separating key straight/direct losses to divider virtually did not change.

The obtained results showed, besides the fact that the guarantee of high insulation in the directed divider of power is desirable to make the region of transition from the metallic waveguide to the metal-dielectric in the form of the section of rectangular waveguide, which expands in a H- plane (i.e. seemingly to introduce the small Hsectorial matching horn). This substantially decreases direct coupling by the regions of exciting the arms 2 and 3 on the diffracted field, and consequently, it leads to the high decoupling of these lateral arms between themselves.

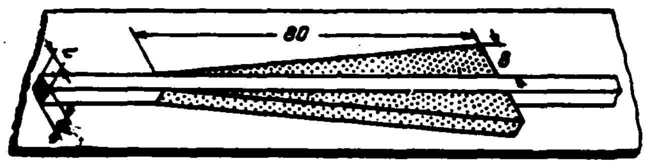

Fig. 6.

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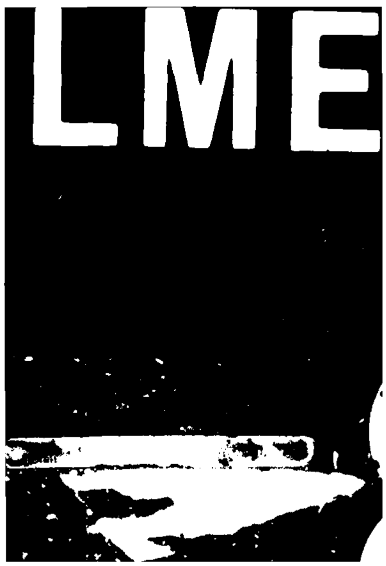
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